

39
33
85

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SOLAR ECLIPSES, 1963 - 1967

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At the request of Commission 13 of the International Astronomical Union, the office of the American Ephemeris agreed to publish advance information on solar eclipses, computed from tabular positions of the Sun and Moon prepared for the purpose in the British Nautical Almanac Office. The data concerning all solar eclipses of 1960, 1961, 1962, and the total solar eclipse of 1963 have been published in *U. S. Naval Observatory Circular* No. 59.

The present circular gives the results of the definitive calculations for the annular eclipse of 1963, and for all solar eclipses in 1964, 1965, 1966 and 1967.

In conformity with the adoption of Ephemeris Time in the national ephemerides, beginning in 1960, the arguments are given here in Ephemeris Time (E.T.), and the longitudes are referred to the "Ephemeris meridian" as defined by D. H. Sadler, *Occasional Notes of the R. A. S.*, No. 17, vol. 3, 1954.

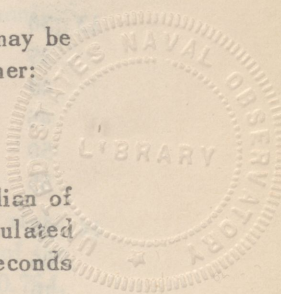
Once the value of ΔT is known, the accurate position of the track may be obtained very simply, and without interpolation, in the following manner:

Change all time-arguments into Universal Time by setting

$$UT = E.T. - \Delta T$$

Leave latitudes unchanged, and refer the longitudes to the meridian of Greenwich by applying $-1.0027 \Delta T$ as a correction to the tabulated longitudes, remembering that a second of time is equivalent to 15 seconds of arc.

The value of ΔT can be accurately determined only in arrear. Past experience shows that a value estimated five years in advance may be in error by amounts up to 5 seconds. A predicted value, applicable to all data in this *Circular*, is + 37 seconds of time.



ANNULAR ECLIPSE OF 1963 JANUARY 25

Central Line

Ephemeris Time	Latitude	Ephemeris Longitude	Duration on Central Line	Width of Path
h m	° '	° '	m s	mi
Limit	- 35 23	+ 101 47	. . .	...
12 05	39 48.8	89 13.5	1 01.3	46
10	42 53.4	79 49.5	0 56.1	39
15	44 49.0	73 15.9	0 52.2	34
20	46 14.3	67 49.1	0 48.9	31
25	47 20.4	63 00.2	0 46.0	28
12 30	- 48 12.4	+ 58 36.0	0 43.3	25
35	48 53.3	54 29.6	0 40.9	23
40	49 24.8	50 36.9	0 38.7	21
45	49 48.3	46 55.3	0 36.6	20
50	50 04.5	43 22.9	0 34.7	18
55	50 14.3	39 58.5	0 33.0	17
13 00	- 50 18.0	+ 36 41.3	0 31.5	16
05	50 16.3	33 30.5	0 30.1	15
10	50 09.4	30 25.7	0 28.9	14
15	49 57.7	27 26.4	0 27.9	13
20	49 41.4	24 32.3	0 27.0	13
25	49 20.8	21 43.1	0 26.3	13
13 30	- 48 56.0	+ 18 58.2	0 25.8	13
35	48 27.3	16 17.6	0 25.4	12
40	47 54.7	13 40.7	0 25.2	12
45	47 18.4	11 07.2	0 25.1	12
50	46 38.5	8 36.7	0 25.3	13
55	45 55.1	6 08.7	0 25.6	13
14 00	- 45 08.0	+ 3 42.7	0 26.1	13
05	44 17.4	+ 1 18.2	0 26.8	13
10	43 23.2	- 1 05.6	0 27.6	14
15	42 25.3	3 29.4	0 28.7	15
20	41 23.5	5 54.0	0 29.9	16
25	- 40 17.6	- 8 20.5	0 31.2	17

ANNULAR ECLIPSE OF 1963 JANUARY 25 (Continued)

h	m	°	'	°	'	m	s	mi
14	30	- 39	07.3	- 10	50.3	0	32.8	18
	35	37	51.9	13	24.9	0	34.6	20
	40	36	31.0	16	06.7	0	36.6	22
	45	35	03.3	18	58.6	0	38.8	24
	50	33	27.4	22	05.2	0	41.3	26
	55	31	40.7	25	33.7	0	44.1	29
15	00	- 29	38.4	- 29	37.2	0	47.4	32
	05	27	09.8	34	45.8	0	51.4	37
	10	23	33.0	42	56.4	0	57.3	44
Limit		- 19	58	- 52	19	• • • •		• • •

In the eclipse of 1963 January 25, geocentric conjunction will occur in right ascension $20^{\text{h}} 28^{\text{m}} 49^{\text{s}}.35$, at E.T. $25^{\text{d}} 13^{\text{h}} 29^{\text{m}} 25^{\text{s}}.3$, the declination of the Sun being $-19^{\circ} 03' 12''.0$.

West longitudes are positive.

PARTIAL ECLIPSE OF 1964 JANUARY 14

In the eclipse of 1964 January 14, geocentric conjunction will occur in right ascension $19^{\text{h}} 42^{\text{m}} 17^{\text{s}}.51$, at E.T. $14^{\text{d}} 20^{\text{h}} 19^{\text{m}} 17^{\text{s}}.2$, the declination of the Sun being $-21^{\circ} 21' 47''.8$. The greatest eclipse will have the magnitude 0.559, at longitude $-43^{\circ} 03'$, latitude $-68^{\circ} 14'$.

The eclipse will be observable in Antarctica, the southern part of Tasmania, the Falkland Islands, and the southern tip of South America.

PARTIAL ECLIPSE OF 1964 JUNE 10

In the eclipse of 1964 June 10, geocentric conjunction will occur in right ascension $5^{\text{h}} 13^{\text{m}} 28^{\text{s}}.61$, at E.T. $10^{\text{d}} 04^{\text{h}} 13^{\text{m}} 16^{\text{s}}.9$, the declination of the Sun being $+23^{\circ} 00' 46''.0$. The greatest eclipse will have the magnitude 0.754, at longitude $-135^{\circ} 38'$, latitude $-65^{\circ} 00'$.

The eclipse will be observable in Australia, except the northern coast, Tasmania, and most of New Zealand.

PARTIAL ECLIPSE OF 1964 JULY 9

In the eclipse of 1964 July 9, geocentric conjunction will occur in right ascension $7^{\text{h}} 14^{\text{m}} 48^{\text{s}}.20$, at E.T. $9^{\text{d}} 11^{\text{h}} 13^{\text{m}} 16^{\text{s}}.9$, the declination of the Sun being $+22^{\circ} 19' 49''.6$. The greatest eclipse will have the magnitude 0.322, at longitude $+173^{\circ} 04'$, latitude $+67^{\circ} 36'$.

The eclipse will be observable in northern Asia, northern Canada, and the north polar regions.

PARTIAL ECLIPSE OF 1964 DECEMBER 3 - 4

In the eclipse of 1964 December 3 - 4, geocentric conjunction will occur in right ascension $16^{\text{h}} 41^{\text{m}} 37^{\text{s}}.88$, at E.T. $4^{\text{d}} 01^{\text{h}} 00^{\text{m}} 28^{\text{s}}.2$, the declination of the Sun being $-22^{\circ} 13' 19''.7$. The greatest eclipse will have the magnitude 0.752, at longitude $+173^{\circ} 34'$, latitude $+64^{\circ} 18'$.

The eclipse will be observable in the North Pacific Ocean, Hawaii, Japan, the northeast coast of Asia, the Aleutian Islands, and the southwestern peninsula of Alaska.

TOTAL ECLIPSE OF 1965 MAY 30

Central Line

Ephemeris Time	Latitude	Ephemeris Longitude	Duration on Central Line	Width of Path
h m	° '	° '	m s	mi
Limit	- 36 18	- 170 51	. . .	...
19 45	30 35.1	+ 177 06.6	2 38.1	88
50	26 19.3	169 37.2	2 59.9	94
55	23 21.4	164 56.0	3 16.2	97
20 00	- 20 56.8	+ 161 21.8	3 30.1	100
05	18 52.5	158 25.2	3 42.6	102
10	17 02.2	155 53.2	3 53.9	105
15	15 22.7	153 38.4	4 04.4	106
20	13 51.8	151 36.3	4 14.1	109
25	- 12 28.0	+ 149 43.7	4 23.1	110

TOTAL ECLIPSE OF 1965 MAY 30 (*Continued*)

h	m	°	'	°	'	m	s	mi
20	30	-	11 10.4	+	147 58.5	4	31.4	112
	35		9 58.1		146 19.2	4	39.1	113
	40		8 50.7		144 44.3	4	46.1	115
	45		7 47.6		143 13.1	4	52.4	116
	50		6 48.7		141 44.5	4	58.0	117
	55		5 53.6		140 17.9	5	02.9	119
21	00	-	5 02.0	+	138 52.8	5	07.1	120
	05		4 14.0		137 28.5	5	10.5	120
	10		3 29.4		136 04.6	5	13.1	122
	15		2 48.0		134 40.7	5	14.9	123
	20		2 09.9		133 16.3	5	15.8	123
	25		1 35.1		131 51.0	5	15.9	124
21	30	-	1 03.5	+	130 24.4	5	15.1	124
	35		0 35.2		128 56.0	5	13.3	124
	40	-	0 10.4		127 25.4	5	10.7	124
	45	+	0 11.0		125 52.1	5	07.2	124
	50		0 28.6		124 15.5	5	02.7	123
	55		0 42.4		122 35.0	4	57.3	122
22	00	+	0 52.0	+	120 49.8	4	51.0	120
	05		0 57.0		118 59.1	4	43.8	119
	10		0 57.2		117 01.7	4	35.6	117
	15		0 51.7		114 56.1	4	26.5	116
	20		0 39.8		112 40.4	4	16.5	113
	25	+	0 20.4		110 12.0	4	05.5	111
22	30	-	0 08.3	+	107 26.9	3	53.4	109
	35		0 49.0		104 18.6	3	40.0	105
	40		1 46.7		100 35.9	3	25.0	102
	45		3 11.6		95 53.8	3	07.4	97
	50		5 38.8		88 48.4	2	44.2	91
Limit		-	9 55	+	77 49	• • •		• • •

In the eclipse of 1965 May 30, geocentric conjunction will occur in right ascension $4^{\text{h}} 30^{\text{m}} 05^{\text{s}}.47$, at E.T. $30^{\text{d}} 21^{\text{h}} 06^{\text{m}} 06^{\text{s}}.4$, the declination of the Sun being $+21^{\circ} 50' 12''.1$.

ANNULAR ECLIPSE OF 1965 NOVEMBER 23

Central Line				
Ephemeris Time	Latitude	Ephemeris Longitude	Duration on Central Line	Width of Path
h m	° '	° '	m s	mi
Limit	+ 37 53	- 65 30	. . .	...
2 35	31 10.5	80 05.1	3 23.0	102
40	27 31.1	86 21.9	3 26.2	97
45	24 45.9	90 34.1	3 28.8	94
50	22 27.4	93 49.1	3 31.2	91
55	20 25.7	96 30.3	3 33.5	90
3 00	+ 18 36.0	- 98 48.8	3 35.7	88
05	16 55.7	100 51.1	3 37.8	86
10	15 22.8	102 41.4	3 39.9	85
15	13 56.2	104 22.3	3 41.9	84
20	12 35.0	105 55.9	3 43.9	83
25	11 18.4	107 23.7	3 45.9	82
3 30	+ 10 06.1	- 108 47.0	3 47.9	82
35	8 57.6	110 06.5	3 49.8	82
40	7 52.6	111 23.2	3 51.6	82
45	6 50.8	112 37.6	3 53.4	82
50	5 52.2	113 50.4	3 55.1	82
55	4 56.4	115 02.0	3 56.7	82
4 00	+ 4 03.4	- 116 12.8	3 58.2	82
05	3 13.2	117 23.2	3 59.6	82
10	2 25.6	118 33.7	4 00.9	83
15	1 40.6	119 44.5	4 02.0	83
20	0 58.2	120 56.1	4 03.0	84
25	+ 0 18.4	122 08.7	4 03.8	85
4 30	- 0 18.8	- 123 22.8	4 04.3	85
35	0 53.3	124 38.6	4 04.7	86
40	1 25.1	125 56.6	4 04.9	86
45	1 54.1	127 17.1	4 04.8	87
50	2 20.2	128 40.7	4 04.4	88
55	- 2 43.2	- 130 07.8	4 03.8	89

ANNULAR ECLIPSE OF 1965 NOVEMBER 23 (*Continued*)

h m	° '	° '	m s	mi
5 00	- 3 02.9	- 131 39.1	4 02.9	90
05	3 19.1	133 15.2	4 01.8	90
10	3 31.4	134 57.0	4 00.3	91
15	3 39.5	136 45.5	3 58.6	92
20	3 42.9	138 42.1	3 56.6	93
25	3 40.7	140 48.5	3 54.3	94
5 30	- 3 32.1	- 143 07.3	3 51.8	95
35	3 15.6	145 42.0	3 48.9	97
40	2 49.0	148 38.3	3 45.6	98
45	2 08.4	152 06.0	3 41.9	101
50	- 1 05.8	156 25.5	3 37.7	103
55	+ 0 41.9	162 37.1	3 32.2	108
Limit	+ 5 01	- 175 04	• • •	• • •

In the eclipse of 1965 November 23, geocentric conjunction will occur in right ascension $15^{\text{h}} 53^{\text{m}} 59^{\text{s}}.66$, at E.T. $23^{\text{d}} 04^{\text{h}} 00^{\text{m}} 45^{\text{s}}.4$, the declination of the Sun being $-20^{\circ} 17' 32''.0$.

ANNULAR ECLIPSE OF 1966 MAY 20

Ephemeris Time	Central Line		Duration on Central Line	Width of Path
	Latitude	Ephemeris Longitude		
h m	° '	° '	m s	mi
Limit	+ 1 52	+ 30 14	• • •	• • •
7 55	3 23.1	26 17.7	0 56.2	40
8 00	+ 8 31.3	+ 15 34.7	0 47.1	31
05	11 30.6	10 33.1	0 41.8	26
10	13 57.3	6 52.8	0 37.6	23
15	16 06.4	3 53.8	0 33.8	20
20	18 03.8	+ 1 20.3	0 30.4	17
25	19 52.8	- 0 55.9	0 27.3	15
8 30	+ 21 35.2	- 2 59.9	0 24.5	13
35	23 12.1	4 55.0	0 21.9	11
40	+ 24 44.6	- 6 43.4	0 19.5	10

ANNULAR ECLIPSE OF 1966 MAY 20 (Continued)

h	m	°	'	°	'	m	s	mi
8	45	+	26 13.1	-	8 27.0	0	17.3	9
	50		27 38.2		10 07.1	0	15.2	7
	55		29 00.2		11 44.7	0	13.4	6
9	00	+	30 19.3	-	13 20.9	0	11.7	6
	05		31 35.7		14 56.4	0	10.2	5
	10		32 49.6		16 31.9	0	08.8	4
	15		34 01.0		18 08.2	0	07.7	3
	20		35 10.1		19 45.6	0	06.7	3
	25		36 16.9		21 25.0	0	05.9	2
9	30	+	37 21.3	-	23 06.7	0	05.3	2
	35		38 23.4		24 51.3	0	04.9	2
	40		39 23.0		26 39.4	0	04.6	2
	45		40 20.2		28 31.5	0	04.6	2
	50		41 14.8		30 28.1	0	04.7	2
	55		42 06.7		32 29.7	0	05.1	2
10	00	+	42 55.7	-	34 37.0	0	05.6	2
	05		43 41.6		36 50.5	0	06.3	2
	10		44 24.1		39 10.9	0	07.2	3
	15		45 03.1		41 38.9	0	08.3	3
	20		45 38.1		44 15.0	0	09.6	4
	25		46 08.7		47 00.2	0	11.1	5
10	30	+	46 34.5	-	49 55.2	0	12.8	6
	35		46 54.9		53 01.1	0	14.7	6
	40		47 09.2		56 19.1	0	16.8	8
	45		47 16.5		59 50.7	0	19.1	9
	50		47 15.7		63 37.8	0	21.6	10
	55		47 05.4		67 43.1	0	24.4	12
11	00	+	46 43.4	-	72 10.6	0	27.4	14
	05		46 06.6		77 06.7	0	30.8	17
	10		45 09.9		82 43.4	0	34.6	20
	15		43 42.2		89 26.0	0	39.1	23
	20		41 10.9		98 36.2	0	44.9	29
Limit		+	36 01	-	113 35	• • •		• • •

In the eclipse of 1966 May 20, geocentric conjunction will occur in right ascension $3^{\text{h}} 46^{\text{m}} 49^{\text{s}}.28$, at E.T. $20^{\text{d}} 09^{\text{h}} 51^{\text{m}} 44^{\text{s}}.6$, the declination of the Sun being $+19^{\circ} 55' 30''.1$.

TOTAL ECLIPSE OF 1966 NOVEMBER 12

Central Line				
Ephemeris Time	Latitude	Ephemeris Longitude	Duration on Central Line	Width of Path
h m	° '	° '	m s	mi
Limit	+ 2 00	+ 104 09	. . .	...
12 45	- 1 21.1	95 11.3	0 36.2	25
50	5 12.9	87 16.4	0 49.3	32
55	7 59.1	82 35.2	0 58.3	37
13 00	- 10 20.7	+ 79 02.7	1 05.8	40
05	12 27.9	76 07.8	1 12.3	43
10	14 25.4	73 37.0	1 18.1	45
15	16 15.7	71 22.7	1 23.3	47
20	18 00.2	69 20.4	1 28.1	48
25	19 40.1	67 26.9	1 32.4	49
13 30	- 21 16.0	+ 65 39.9	1 36.4	50
35	22 48.5	63 57.9	1 40.0	51
40	24 18.1	62 19.4	1 43.3	52
45	25 44.8	60 43.2	1 46.2	52
50	27 09.2	59 08.6	1 48.8	52
55	28 31.2	57 34.6	1 51.0	52
14 00	- 29 51.0	+ 56 00.4	1 52.9	52
05	31 08.7	54 25.5	1 54.5	53
10	32 24.5	52 49.1	1 55.7	52
15	33 38.2	51 10.6	1 56.6	52
20	34 49.9	49 29.4	1 57.1	52
25	35 59.6	47 44.8	1 57.3	52
14 30	- 37 07.2	+ 45 56.3	1 57.0	52
35	38 12.7	44 03.1	1 56.5	52
40	39 15.8	42 04.5	1 55.5	51
45	40 16.6	39 59.8	1 54.2	51
50	41 14.7	37 48.2	1 52.4	50
55	42 09.9	35 28.7	1 50.3	49
15 00	- 43 02.0	+ 33 00.6	1 47.8	48
05	43 50.6	30 22.6	1 44.9	48
10	- 44 35.2	+ 27 33.5	1 41.5	47

TOTAL ECLIPSE OF 1966 NOVEMBER 12 (*Continued*)

h	m	°	'	°	'	m	s	mi
15	15	- 45	15.2	+ 24	32.1	1	37.8	46
	20	45	50.1	21	16.6	1	33.7	44
	25	46	18.9	17	45.1	1	29.0	44
15	30	- 46	40.6	+ 13	55.1	1	24.0	42
	35	46	53.7	9	43.2	1	18.5	40
	40	46	56.0	+ 5	04.9	1	12.3	38
	45	46	44.6	- 0	07.4	1	05.6	36
	50	46	14.3	6	06.3	0	58.0	33
	55	45	14.9	13	18.8	0	49.1	29
16	00	- 43	16.6	- 23	08.5	0	37.6	25
Limit		- 38	29	- 39	53	• • •		• • •

In the eclipse of 1966 November 12, geocentric conjunction will occur in right ascension $15^{\text{h}} 09^{\text{m}} 15^{\text{s}}.09$, at E.T. $12^{\text{d}} 14^{\text{h}} 37^{\text{m}} 05^{\text{s}}.6$, the declination of the Sun being $-17^{\circ} 40' 53''.3$.

PARTIAL ECLIPSE OF 1967 MAY 9

In the eclipse of 1967 May 9, geocentric conjunction will occur in right ascension $3^{\text{h}} 03^{\text{m}} 25^{\text{s}}.89$, at E.T. $9^{\text{d}} 15^{\text{h}} 36^{\text{m}} 04^{\text{s}}.5$, the declination of the Sun being $+17^{\circ} 17' 13''.8$. The greatest eclipse will have the magnitude 0.720, at longitude $+168^{\circ} 30'$, latitude $+62^{\circ} 37'$.

The eclipse will be observable in North America, Greenland, Iceland, northern Scandinavia, and the north polar regions.

TOTAL ECLIPSE OF 1967 NOVEMBER 2

This eclipse will not be central, the closest approach of the axis of shadow to the surface of the earth being approximately 14 miles, at longitude $+28^{\circ}12'$, latitude $-62^{\circ}09'$, where the greatest eclipse will occur.

The eclipse will be total in the region bounded by the Northern Limit of Umbra and a section of the curve "Maximum Eclipse at Sunrise".

Ephemeris Time	Northern Limit of Umbra		Maximum Eclipse at Sunrise	
	Latitude	Ephemeris Longitude	Latitude	Ephemeris Longitude
h m	° '	° '	° '	° '
Limit	- 56 22	+ 18 46	- 56 22	+ 18 46
5 30	59 49.0	12 47.2	57 52.4	20 58.4
35	63 02.9	12 31.6	60 18.2	24 52.7
40	65 45.2	15 23.1	62 40.0	29 11.9
45	67 55.2	21 43.8	64 57.1	34 02.4
50	68 18.4	35 41.9	67 08.4	39 32.7
Limit	- 67 18	+ 39 58	- 67 18	+ 39 58

In the eclipse of 1967 November 2, geocentric conjunction will occur in right ascension $14^{\text{h}} 26^{\text{m}} 59^{\text{s}}.50$, at E.T. $2^{\text{d}} 06^{\text{h}} 25^{\text{m}} 03^{\text{s}}.2$, the declination of the Sun being $-14^{\circ} 32' 45''.2$.